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(INTRODUCTORY TO THE SECOND COURSE.)

BY

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A Lecture delivered in King's College, London, on Wednesday, 14th March, 1832, by GILBERT T. BURNETT, F.L.S., M.B. R.I. R.C.S., Professor of Botany in the College and to the Medico-Botanical Society, &c. &c. &c.

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GENTLEMEN: Whether Botany as the science which treats of plants, or Plants as the subject-matter of the science, be made our first especial theme, is a point of little comparative importance; for the things studied and the study are, of necessity, so conjoined and blended together, that they always must be connectedly pursued, even though each in turn, as priority is yielded, may seem to be used chiefly in illustration of the other. Knowledge, and the things known, are abstractedly distinct, and hence should ever in theory be distinguished; but in practice they can never be divided.

Did time permit, it might be well to discuss both schemes at once; and to offer an outline of both systems in a single lecture; for the more aspects under which any object can be viewed, the more familiar do we become with its several parts, and the more intimately acquainted with its bearings: but as an hour is scarcely sufficient for even the most cursory glance at one, they must be consecutively pursued, and as the last Course was opened with a practical demonstration of plants as they are found in nature, illustrating each group or section with slight notices of structure, arrangement, and general uses, thus anticipating the difficulty of a definition of vegetables, (which seems often too anxiously obtruded on the attention of the beginner,) it is now proposed, in a similar way, to obviate a similar difficulty in the definition of the study, and by an equivalent demonstration of the several departments into which botany has been distributed, to illustrate the science by reference to its subjects; i. e. by taking examples from the several chief groups or sections into which philosophical research, as well as popular consent, has distributed the multitudinous subjects of the vegetable reign, to illustrate the several departments of the science. We then demonstrated existing plants: we now propose to demonstrate the circumstances under which, as plants, they do exist: the one being the subjective, the other the objective view.

Gentlemen: Without reference to obscure archæological researches, the antiquity of our science may fairly be assumed, for plants were the first beings that ever sprang instinct with life on this terraqueous globe, and their culture and their care

formed man's earliest employment: since, on the third day of the Creation, so soon as the dry land appeared, when, at the Divine behest, the earth brought forth grass and herbs yielding seed, and the fruit tree yielding fruit, and God saw that these works were good; since the Almighty planted a garden eastward in Eden, and put man, whom he had made, therein to dress it and to keep it; i. e. since out of the ground made the Lord God to grow every tree that is pleasant to the sight and good for food, and, to crown his works, created man to wonder and adore, among the numerous natural miracles which demand his notice and solicit his regard, as there are none that have received, perhaps there are few that have deserved, a greater share of attention than the wonders of the vegetable world, than the trees of the forest and the flowers of the field, which afford the chief and once the only means of sustenance to him and his. Hence some knowledge of such plants as are useful for food, as medicines, or in the arts, must have been almost coeval with our race, at least, congenital with the wants of man; and this knowledge, once empirical, and merely the result of casual observation, was then (as fitted best) called *Herb-craft;* but since that the practice has been reduced to principle, it constitutes a science; it is that branch of natural philosophy and natural history now termed Botany. But, as I shall endeavour to convince you, the botany of the natural philosopher is very different from the botany of the world at large; very different from that specious yet unreal mockery of science, that spurious yet popular and fashionable trifling, which, unconscious of the first principles of vegetable physics, contents itself with superficially scanning the names of plants, esteeming that an end which should never be considered as more than a subordinate, a secondary mean. System is but an instrument, and should never be mistaken for the work it is destined to perform: and such botanists as would confine their studies to mere names and schemes, who burden themselves with tools which are worthless when unused, and which they use not for the purposes for which they were designed, are like scholastic pedants who make language their only study, without reference to the truths which language is destined to reveal; they are always moving, yet never getting on, never getting farther than the threshold of vegetable philosophy; for ever treading as on the wheel, a weary round of never-changing place, of never-ending toil.

Whatever difficulty may have been met with by those who have attempted strictly to define a plant, it might have been reasonably supposed that little could have arisen as to

the definition of the science which treats thereof; and that, so long as vegetables formed the subjects of research, so long such researches would be esteemed botanical: but, no; a schism has been mooted even here, which would doubtless excite astonishment, were it a solitary instance of the waywardness of man. On the contrary, however, it is only one of many such, and forms merely an additional proof of what, even without it, daily experience would have sufficed to shew, viz. that no two things more widely differ than do the correct and vulgar acceptations of the terms of science. Hence has arisen the necessity, in the exordium of a discourse, to explain the meanings which should be respectively attached thereto; and thus it is with botany, for this word (Βοτανη), which in the original signifies herb or grass, in modern language is the term applied to the study of plants in general, though some would improperly confine it to the mere art of distinguishing the various particular individuals of the vegetable world. Against this, however, I always have, and ever shall protest; for as well might the meaning be restrained to the original herb or grass as to the diagnosis of the plants alone, for this, which is too often pursued as the sole end and aim, although a part, is but a part, and that not the most important or interesting part of philosophic botany. The systematic branch is no doubt a useful and desirable study, but to those who talk of "Vegetable Physiology and Botany," as if they were sciences distinct, I would declare that, with a less absolute abuse of words, might that man be called a botanist who is well acquainted with the structure, functions, and laws of life in vegetables, although he might know not the name of a single plant, than he who could name each plant that grows, if ignorant of vegetable physics, in which we comprehend the anatomy, physiology, chemistry, geography, geology, and other less important branches of the natural history of plants.

Plants are the subjects of botany, their attributes the objects of the science; and, as with other things, these are essential, technical, and accidental; those, universal, general, and special; these, the objects of the study; those, the subjects to be studied; and to the reciprocal elucidation of both, the science, as a whole, is equally devoted. And, first, of the subjects.

The multifarious productions of the vegetable world, which are all the legitimate particulars of botany, have, by common consent, been marshalled in successive ranks, called species, genera, types, and orders; and these have been as-

sociated into general classes, and still more general regions, the which, in their aggregate, become the more or less general sections of the universal subject: for example, the vegetable reign, or kingdom, is demarcated into three great regions, comprehending nine large sections, called by different names by different persons, and at different times, but most curiously coincident as to the chief individuals that each rank respectively includes; viz. the Di- Mono- and A-cotyledons of Linnæus and Jussieu; the Exogenæ, Endogenæ, and Cellulares of De Candolle; the Phanero-, Crypto-, and A-gamæ of some modern authors; the Cresses, Leas, and Musts or Plants, Herbs, and Worts of our provincial dialects; by which names, translatable by the words Cresc-affines, Term-affines, and Myc-affines, we have ventured to propose they should be called.

In consonance with the distribution of plants into three regions and nine classes, subjective botany has already in practice (as I will shew it should be in theory,) been distinguished into various subordinate sciences, on several of which names have been long imposed, although the others are not thus denominated, e. g. Muscologia, or the science of the mosses, which the learned Professor Hooker has made (not his sole, for he has laboured much in every province, but) his more especial study; Algalogia, or the science of the flags or algæ, which Dillwyn, Turner, and the indefatigable Greville have so industriously investigated; and Mycologia, the science of the fungi, or (as this term should include the whole of the three just-named departments, although, like Muscologia, it be an hybrid word,) we had rather write Fungologia, the science of the mushrooms or fungi, which Fries, and again our own Greville, with Dillenius, Sowerby, Bolton, and others, have reduced to lucid order, and rendered so curiously interesting. The same observations might be made on, and the same principle of subdivision and nomenclature be extended to the ferns, the grasses, &c.; for the several great sections or classes of plants form sister sciences, analogous to those subdivisions which have been found so useful in zoology, which consists of Ornithology, Herpetology, Ichthyology, Entomology, Helminthology, and so on, each referring especially in turn to the birds, the reptiles, and the fish, insects, worms, &c.; no one zoologist paying equal attention to all, but, having a general knowledge of the whole, dedicates his time especially to one; and much benefit would result to our science, were a similar plan to be adopted by and naturalised amongst us.

Secondly, of the objects of the science, viz. the attributes

of the subjects which are their absolute or essential qualities, their comparative relations, and their accidental uses.

The *positive* attributes of plants are those qualities which are *absolute* and *essential* to their physical existence; and the study of these constitutes that section called Organic Botany, or Vegetable Physics.

The *accidental* attributes are those qualities of plants which, although *extrinsic* and not essential to vegetable existence, are often to other beings of *superlative* importance: such are the uses, natural and artificial, and the purposes to which plants either have been, are, or might be applied, as food, as medicines, or in the arts. This section comprehends several subordinate sciences, which in the aggregate form Economic Botany, or the study of Vegetable Utilities.

The *technical* or *comparative* spring from, and are founded upon, the essential and accidental attributes just referred to. This section of the science includes the imposition of names, and the philosophical application of all the various means by which plants are interdistinguished among themselves, and contradistinguished from other coordinate physical existences. This department being chiefly devoted to the theory and practice of arrangement, has hence been termed Systematic Botany, or the study of Vegetable Diagnosis.

The distribution of our subject is therefore trine, and the distribution of our object is threefold also; for, as plants associate naturally into three great regions, so likewise their attributes are

1. Absolute, essential, or positive;
2. Extrinsic, accidental, or superlative;
3. Relative, technical, or comparative.

From these statements it is obvious that botany should be studied both in an objective and in a subjective light, and that each severally initiates a different scheme of investigation. As both courses must be followed, it little matters (as we have already said,) to which precedence may be given; for, although the designs are different, the means are similar and the end the same.

In the subjective scheme, each individual or particular group is uninterruptedly examined in all its aspects, viewed in every position, and submitted to every light; i. e. structure is anatomically examined, functions physiologically investigated, composition chemically considered, &c.: hence, the same subject is contemplated under all its phases before another is submitted to examination; while, on the contrary, in the objective view, a similar examination is uninterruptedly

pursued through an entire series of individuals, through the whole vegetable reign, or the whole organic realm: that is, the anatomy of all is investigated, then the physiology, then the chemistry, and so forth: thus giving rise, as before, each to its respective science; here, of vegetable anatomy, physiology, chemistry, and so on; there, of fungology, algalogy, muscology, &c.; in the one case, applicable to the distribution of the subjects; in the other, to that of the objects of vegetable philosophy.

From one of these schemes pursued to its full extent, as referrible to nature as a whole, result the general sciences of botany, zoology, &c., which investigate respectively all the attributes of each kingdom, or of each section separately, both of the organic and of the inorganic world: from the other spring the comparable sciences of general or comparative anatomy, physiology, chemistry, and so forth, which, under the heads of human, comparative, and vegetable anatomy and physiology, of organic and inorganic chemistry, investigate respectively the structure, the functions, the constituents, and all the other attributes of all existing beings. In the one scheme, we view all things in the same light; in the other, the same thing in all lights; or, to take an illustration from my legal colleague, in the one system we examine each witness separately by a succession of counsel, before we call the next; and in the other we bring a succession of witnesses to be examined by the same counsel, before we transfer them to another court, or permit them to be examined by another counsel;—or, to borrow a figure from the chemical professor, in the first we bring a succession of tests to act upon the same substance, and in the other a succession of substances to be tried by the same test.

From this it will appear that botany, as a science, may be described, on the one hand, as subjective or objective, and, on the other, as theoretical, practical, or mixed, and either (according to its extent,) universal, general, or particular: e. g. plants may be studied either in immediate connexion with other natural existences, when the investigation of their structure, their functions, their alliances, their properties, their habits, and their uses, become integral parts of the general sciences of anatomy, physiology, chemistry, geography, geology, and so on, or the several parts of these general sciences which relate to plants, without being rudely severed, may be conveniently distinguished and especially allied; so that, when the anatomy, physiology, chemistry, geography, geology, arrangement, habits, uses, &c. of plants are conjunctively studied, they will become the

several objective branches of universal botany, and the various pursuits of the philosophic botanist.

Nor in such pursuits, discursive as the list may sound, does the botanist wander from his rightful path; neither, when encroaching, does he trespass with unbidden foot, nor presume an unwelcome guest upon the provinces or the privileges of his colleagues; for, whatever his science gains, it imparts as much, or more; the advantages of communion are reciprocal, and it is indeed one of the highest and most valued privileges of philosophy, that each branch gains more than it gives by cherishing this system of liberal association. Things which should thus be inseparably conjoined, let none essay then rudely to tear asunder; for, although a distinct consideration of the several departments of natural history and philosophy becomes, from the extent of the study, indispensable, still the division is not the less artificial, and continual reference must be made from each to the facts and truths included in the other.

Now, what is true of nature as a whole, and of the vegetable kingdom as one first grand section, is true of each region and class of plants in general, as well as of each individual species and variety in particular; thus giving rise, according to their relative extent, to general and special botany: for, as universal botany consists of the investigation of all plants, in all circumstances, general botany consists of a similar examination of the general types or classes, and special botany of a like research into any particular group or species. Hence have we those useful and elaborate monographs, and those more succinct yet frequent essays, with which our journals of science and literature teem, which do so much honour to their several authors, and are of such vital importance to the onward progress of philosophy; for these are, as it were, the only sure foundation-stones, thus raised by the miners of science from the quarries of truth, with which the general naturalist or architect can build the temple of human knowledge.

Among the most valuable and beautiful of such special works, I cannot omit the mention of Lambert's "Pinus," one of the most splendid volumes that ever issued from the botanic press, or of the Duke of Bedford's "Salictum Woburnense;" Spix and Martius on the Palms, Michaux on the Oaks of America, Lindley on the Orchides and Roses, and Brown and De Candolle on many sections, with numerous other similar productions which crowd upon the recollection, but of which time will not now permit even a bare catalogue to be made. To the Transactions of the Linnæan, Horticultural,

and other learned Societies; to the practical cultivators of indigenous and exotic plants, among whom Knight, Barclay, the Loddidges, the Society of Apothecaries, and others, deserve honourable mention; as well as to the journals of travellers, the special departments of botany likewise stand deeply indebted. Few have ever done more for natural science than Humboldt and Bonpland; Hancock, Douglass, and Wallich claim also grateful notice: the latter more especially from us, as through him the Honourable East India Company have presented to the Herbarium of this College, (the botanical museum of which we are very anxious to render a useful place of reference for students,) a valuable selection from the plants collected by him under their auspices in India; on a scale of magnificence and with a spirit of liberality truly oriental; for the Company, after the plants had been collected, freighted a vessel to bring them home, and have subsequently distributed the duplicates as presents to the learned throughout the whole of Europe. But to return from this digression:

Each of these modes of investigation to which I have referred has advantages peculiarly its own: the one leads to enlarged and liberal views of the general laws which regulate the whole, the other ensures an intimate acquaintance with the habits and characters of particular individuals, and, as always is the case, the more comprehensive the less defined, and the less discursive the more decided are our views. Hence neither of these methods should be neglected, neither be exclusively pursued, but both be judiciously cherished and rendered helps mete for each other; and in the lectures to be delivered in this College I propose to combine, as far as may be, the advantages of both.

Let me then repeat, that botany is one grand division of natural knowledge, distinguished as a separate science: it consists of three subordinate departments, all of them intimately allied with each other, and closely connected with the correlative general sciences, of which indeed, under another view, they severally form parts. Thus philosophic botany, or the true science of plants, consists not merely either of an account of their structure and their functions, or in a detail of their names, their characters, and their arrangement, or in a history of their habitudes and uses, but comprises all; and hence the three great subdivisions of the science into organic botany, or vegetable physics; systematic botany, or vegetable diagnosis; and economic botany, or vegetable utilities: and these several topics, each in itself important, but too often disconnectedly pursued, lose much by disunion both of

interest and value: this should never be forgotten by those who wish to study philosophically the principles, the relations, and the purposes of botany.

Gentlemen, I have now discussed, in general terms, the theory of botany; I have compressed the fruits of much reflection into as short a space as a due regard for perspicuity left possible; and yet I fear, that to such as come fresh and unprepared for any abstract views of a demonstrative science, these truths may have seemed tedious, from their length; although, if obscure, they must have been made so merely from their brevity. I would fain have been more copious in the details, but I fear that, even as it is, I have detained you longer from the demonstrations than is politic in an introductory address. Let us, then, at once begin our practical illustrations; and first of the principles of the science, better known as Organic Botany, or the study of Vegetable Physics; which, being a very extensive province, the maxim "divide and conquer," which induced the first distinction of the science into the subjective and the objective views, and the subsequent division of both into several branches, still persuades to a further distribution of each branch into various subordinate departments: and hence vegetable physics, accordingly as it treats of the several essential attributes of plants, gives rise to the structural, functional, chemical, mechanical, zoological, geographical, and geological sections, each relating especially to the topic its name imports.

And first of Structural Botany, or Vegetable Anatomy, or, as the supremacy of nomenclature would have it, *Phytanatomy.*

Of structural botany, a very extensive and important section, and one to be fully followed out hereafter, time will permit me to offer now but very meagre illustrations: we must content ourselves with almost solitary examples both of external and of internal structure.

As the most notorious of the external attributes of plants, I select their size and figure, for in both the difference is extreme. With respect to size, we have plants on the one hand almost, and others altogether, invisible to the naked eye, and not improbably some that even elude the vigilance of the doublet lens; while, as contrasts to these infinitesimals of vitality, we have palms, and pines, and oaks, from one to two and three, or even, as some report, four hundred feet in height, and of proportionable thickness. "Miracula fugiunt" often forms a comment to the relation of marvels such as these, and true enough it is that wonders, like the visible horizon, do frequently recede as we journey towards them,

and often evade our practical researches; but of the above the evidences are within our reach, and in fact are now before us: for this black dust, known familiarly as the smut in wheat, and which is so small in each individual plant that it becomes conspicuous only by their association, and which, small as it is, is not the smallest species; for this is a sample of the Reticularia maxima, and yet each microcosm contains, as Fries (a mycologist of no mean celebrity) affirms, 10,000,000 sporules, i. e. embryo plants, equivalent to seeds, or rather to buds or offsets. So subtle are these minute vegetable existences, that they elude our ordinary vision, and are scarcely seen unless when in multitudes, and then they resemble smoke, and are raised like vapour into the air. Contrast these and many similar protophytes, or even the microscopic yet complicated phasca, so curious in their minuteness, with the royal oak and the lordly pine. this measuring three hundred feet in height, that six-and-twenty yards in girth. Of course, such specimens cannot be stored in our herbaria; yet the Erie walnut, which measured thirty-six feet in circumference at the level of the ground, was seen by many of you in this city only a few months ago, and I believe it is to be seen, by any one who wishes it, at the present time; but, above all, the Cowthorpe oak is still living with us, and probably uniting by its existence three millennia together; for the old oak in Salcey wood, which is little more than half its size, has been computed to have lived upwards of 1500 years.

The form of plants is not less various than their size: some possess roots, and stems, and branches of different structures, bearing multitudes of thorns or prickles, with leaves, tendrils, flowers, and fruit, in every conceivable variety; whilst others, as the Truffle, consist apparently of nothing more than root; others, as the Testudinaria, seem little else than shapeless trunks; and others, as the Aphyteia and Rafflesia, consist of a flower alone: those having neither stem, nor leaf, nor flower; and these having flower only. But this is a subject so entrancing, that I must tear myself at once from the discussion; for I dare not now dilate on the laws which regulate the development and the non-development of these several parts, with their extraordinary transformations into each other; as of the foliage successively into scale, tendril, prickle, leaf-stalk, leaf, flower, and fruit; for the substance of the peach, the pear, the apple, and the cherry is only the disguised and metamorphosed substance of a leaf, as these specimens and diagrams will prove.

A knowledge of the internal structure of the vegetable

body assists greatly in explaining the modifications of its external form; but not only this, they reciprocally become indexes to each other, as certain internal structures only, can assume certain external configurations; at least, we so conclude from the circumstance of their always being found in combination. But what imports it, methinks I hear some caviller object, that we should know the shape, the disposition, and the contents of the cells and tubes of the vegetable frame? I will answer the supposed objector by an illustration; for one fact, in my mind, will far outweigh a volume of assertion. All wood is tubular and cellular, and the different weight, colour, taste, smell, &c. of oak, ebony, poplar, cedar, sandal, and so forth, depend not on the ligneous structure itself, but on the matter the cells contain; for, if ebony be steeped in any fluid which will dissolve the black matter with which its cells are filled, it will become as light and pale as poplar. But to the example. There are two, if not three species of British oak, (the third species is by some, however, considered only as a variety,) one of these alone produces strong and lasting timber fit for naval purposes, i. e. which will endure unchanged the transitions from wet to dry, from heat to cold, and remain unhurt between wind and water. This difference depends on the tubes just mentioned conveying to the cells of which the mass of wood consists, a substance differing in solubility in the different species; so that, when the timber of the one is wet, part of the inspissated extract is dissolved and borne away; and when this is repeatedly done, the cells become more and more void, and the timber light and spongy, so that, during cold weather, the water within it freezing and becoming expanded, the cells and tubes are ruptured, and consequently more readily let in fresh water and let out the solid matter it dissolves; and these successive crops of icicles soon form chinks and rents, extending for many feet. Now, oak is frequently contracted for in building ships, and mill-work, floodgates, locks, and so forth, merely as oak, and often, either through ignorance or fraud, the perishable timber is purveyed instead of the enduring wood: but a knowledge of vegetable structure can, by the aid of a very simple experiment, (the manipulations of which I have described in the thirteenth number of the Journal of Science,) easily detect the fallacy or fraud.

From the positive characters discovered by an investigation of the external and internal structure of plants are deduced the comparative or diagnostic signs which enable the systematic botanist to distinguish plants from each other, and give rise to the second department of our science; of which

hereafter. But as the subject of the oak has been so far discussed, it may not be amiss to anticipate an illustration, and show how structural peculiarities will enable the forester to distinguish between the qualities of the timbers before he fells the trees, or rather, in fact, to predict the kind of wood an oak will form, even while the sapling is just springing from the seed: for it is preposterous to contend that plantations should be raised and nurtured through centuries, and then, at the end of two or three hundred years, the fact should be discovered that such oaks are unfit for shipbuilding, and the first notice of this be from the decay of the vessels, even while upon the stocks. I speak not unadvisedly, nor do I put a case of bare possibility; I merely relate a notorious fact. Plantations of the wrong kind of oak have been made in various parts of this essentially oak-growing and ship-building country, and vessels built of such timber as that to which I have alluded *have split and rotted* on the stocks, and have been obliged to undergo a thorough repair, even before they have been launched. What a lamentable tale it is to read or hear, that a vessel of 120 guns, and which must have cost 120,000*l.*, has been condemned and sold for 25*l.*, as last week's journals tell us was the case, and this, as they report, without having ever seen any actual service. Indeed, the rapid decay of many modern-built vessels, and hence much of the heavy expense of our navy, has been, with some shew of reason, attributed to the use of immature and ill-chosen wood, the applicability of which might easily have been tested, had not botanic knowledge been absent from situations where it ought not to have been found wanting.

But of this enough. I must now hasten to give an illustration or two of Functional Botany, generally called Vegetable Physiology, *Phytology*, or *Phytophysiology*.

The functions of plants are either special, as relating to their own well-being, or general, as having an equally extensive importance to other co-ordinate existences. Thus, the absorption of nutritious fluid by the roots, its ascent through the stem to the leaves, its circulation and assimilation to the substance of the vegetable, although perhaps not wholly designed to benefit the individual alone, are chiefly and primarily so: while the transpiration of plants, and their action on atmospheric air, are functions of equal, if not greater importance to animals, than they are to the plants themselves.

The motion of the sap is ocularly demonstrable; and here is a specimen of Chara so placed beneath the microscope, that the currents of sap traversing its various parts are as evident to our senses as the current of a river, or the circu-

lation in the foot of a frog. Here also are diagrams of its course in the stipules of the Ficus elastica, and the water plantain.

The respiration of plants seems to have been generally misunderstood from this function having been confounded with their digestion, both being parts, in fact, of one great process, that of assimilation; although respiration would seem to perform some other important duty, perhaps in maintaining the irritability of the vegetable. This distinction I endeavoured practically to make out, and a summary of an extended course of experiments, undertaken with this view, were published about two years ago, in the first number of the Journal of the Royal Institution, the result of which may be shortly stated thus: that plants always deteriorate atmospheric air by their respiration, but that by their digestion they much more than compensate for this deterioration; and that, on the whole, they tend to preserve the equilibrium which combustion and the respiration of animals have a tendency to disturb.

Of the light which modern chemistry has thrown on some intricate parts of botany, I cannot speak in too grateful terms, however warm my acknowledgments may seem; for by its means we are enabled to explain many physiological phenomena which, without its aid, were utterly inexplicable: e. g. it has been a constant theme of wonder (and remember that it is not the less a miracle now that we can trace back one further link in the chain of events, for physical causes are but effects; it has been, I repeat, a constant theme of wonder) that from the same soil plants should elaborate such different principles; that, fed, sustained, supported by the same earth, air, and water, one should produce starch, another gum, a third sugar, and so on; that some should abound with bland, others with highly aromatic essential oils, such as the olive, the almond, cinnamon, cajeput, and so forth. That here we should find the most useful medicines, and there the most deadly poisons; as, for example, bark, opium, and rhubarb, contrasted with prussic acid, the upas tieuté, and woorara.

But not only is it strange that by different plants such different products should be formed from the same materials, or that the same plant, in its different parts, should elaborate many of these varieties; as, for example, a tasteless, harmless oil in the kernel of the bitter almond, and a destructive poison in its outer skin, and so forth, as in the cassava, poppy, and many other similar cases; but it is passing strange that the same parts of the same plant should be at different

times so very different in their sensible qualities; at one time consisting almost wholly of insipid lignin, at another being as sour as verjuice, and anon abounding with sugar, impregnated with some delicious aroma.

Phytochymics, discussing the influence of vegetable life on matter, and examining the proximate and ultimate constituents of plants, both while growing and when alive no longer, has thrown much very important light on these obscure and interesting subjects; for hence it is we have learned that, however various the products of the vegetable world may be, (and various to an almost overpowering extent they are,) still all, even the most distinct, consist of charcoal and water, the difference depending upon the ever-varying proportions in which the former is combined with the two elements of the latter: and this is a constitution which can easily be shown, for I need not advertise my present audience that compound bodies maintain their composite existence by virtue of an attraction which holds their principles or elements together, which is found to be of different degrees of energy between different constituents: so that, if to starch, or gum, or sugar, another substance be added which has a greater attraction either for the charcoal or the water, or for either of the elements of the latter, than they have respectively for each other, the original substance will be decomposed, and its elements enter into new combinations, or be in part or on the whole set free; or should the added substance have an attraction for only a small quantity of the oxygen, or the hydrogen, or the charcoal, then such part only will be abstracted, and the remainder left in such proportions as to form the other proximate principles alluded to. Hence is it then, that in the growth of plants, in the ripening of fruit, and so forth, that lignin changes into acids of different kinds, acids into sugar, and so on: and thus, indeed, sugar has been made from old rags, tan from sawdust, vinegar from wood, gum from starch, oxalic acid from sugar and from offal, &c. &c.: the three last of which processes are carried on in this country to a great extent, and with much economical advantage.

To Vegetable Mechanics so little attention has hitherto been paid, that I am reluctant to enter on almost untrodden ground, and yet I am unwilling to pass wholly without notice a theme so important and interesting as that which discusses the evidences of design which are so remarkable in the structure of vegetables, and those mechanical advantages which they reciprocally impart and receive in their relative connections. Let one or two examples of these suffice: and I would direct your attention, in particular, to the mechanical advan-

tages which the feeble radicle gains by its position within the valves of its stony prison, the gates of which it can thus unclose with ease, weak as it seems; while, strong as we comparatively are, it often requires no little exertion, as in the peach, the plum, &c., to crush the shell or to rend the sides asunder. The stings of the nettle are also most curiously constructed: each stimulus being a hollow stilet, something like the fang of a rattlesnake, the channel through which communicates with a reservoir, into which a gland at its base pours an acrid fluid, which, when any thing touches the leaf, is compressed, and the fluid, rising through the duct, escapes through an opening at the side of the style near its point, and thus is lodged in the puncture the instrument has made. The Valisneria, the Cyclamen the Utricularia, and a variety of other plants, exhibit mechanical contrivances equally beautiful, and equally well adapted to fulfil the purposes for which they were evidently designed; but of these more fully in the hereafter lectures.

Botanical Geography, the next point of consideration, is a topic replete with interest; for here we learn how much plants affect and are affected by climate, both physical and geographical, and how they vary according to latitude, longitude, and altitude; for different countries, even in the same or similar parallels, often have vegetations of entirely different characters.

This is a study of such recent date, that the present generation may almost esteem it a science of their own. To the naturalist the truths thus learned are very valuable; and to the medical philosopher it is a study peculiarly important, as the presence or absence of certain plants will often reveal to the eye of science the healthiness or insalubrity of untried or suspected districts; and hence botanical topography not unfrequently becomes one of the surest guides to the local presence or absence of various diseases.

Thus, the colonist should never bivouac nor fix his residence where the Arundo Phragmites flourishes; as it and the Glyceria fluitans and G. aquatica are infallible indications of swampy, marshy districts, and of the probable presence of malaria, even although the tract, as in summer, may seem dry, and be apparently salubrious. A late traveller in Syria thus was warned by the natives not to pitch his tent on the spot that he had selected on account of the luxuriance of the herbage, if he valued his life, or wished to escape a severe attack of fever: this malign influence, however, they seemed erroneously to attribute to the growth of the plants, but of which, in truth, the luxuriant herbage was the index only. Thus also

was the indigenous origin of remittents proved in Gibraltar; and thus the absence of the Laurustinus from the gardens of Switzerland shews the severity of the winter there, as the luxuriance of the vintage proves the warmth of the Swiss summer. Again, the barrenness of the apricots and the vines, while the myrtles and the camellias flourish in the open air, will attest the equability of the temperature in Devonshire and Cornwall throughout the year; the heat of the summer being as insufficient to perfect those, as the mildness of the winter is favorable to these: but of examples there would be no end.

Botanical Topography, which treats of the station as well as the habitation of vegetables, includes much knowledge of extreme importance; and even the more special topography of parasitic plants is not wholly destitute of interest or of value; e. g. many of our lichens, fungi, &c. will grow only on certain plants and trees, or often on only especial parts of them, just as many insects inhabit only one genus or species, or only particular parts of the selected habitat: on the oak there are four or five different sorts of galls formed on different parts by different insects, one on the bud, one on the branch, one on the root, one on the leaf-stalk, one on the flower-stalk, one on the leaf itself, &c.; and we are even told that the gall of the upper side of the oak-leaf is the work of a different species of cynips from that which makes the gall upon the under. However that may be, whether the variety is quite so great or not, I do not by experience know; but this I can from observation state, that there are several, probably four or five different galls, apparently produced by different insects. Now, this is not true of the oak only, or of insects alone, the same thing is observable with regard to the parasitic protophytes; and a German botanist has pointed out a very useful application of this knowledge to aid in the discrimination of the true Cinchona from the spurious barks which in commerce are, either from accident or fraud, frequently commingled with it; for he has shewn that one species of lichen is peculiar to and only found on the true officinal cinchona, while the false barks with which it is adulterated, although often covered with other lichens, never bear any of this diagnostic species. Again, I recollect reading that, some years since, in America, a mortal distemper raged with much severity among the people, and was found to be owing to their feeding upon the Zea mays, or Indian corn, as those who did not eat this bread escaped: but why a grain, in general fit for food, should that season have proved so injurious, no one could tell, until a botanist, look-

ing at the subject by the light of science, found that on each grain of corn, just where it had been torn from the ear, a small poisonous fungus grew, to which the fatal influence had all been owing; just as the deleterious effects of cheese are often attributable to a similar plant. But how was the fungus to be prevented from growing? how was the farmer or the miller to avoid the pest, although its source had been detected? They knew not; they were as impotent as before. But the head of him whose eye discovered the bane revealed the antidote; for, as it was found that this fungus only grew on the parts where the grains had been attached to the stalks of the ears, nothing was more easy than to leave the corn unthreshed until it was wanted to be ground into flour. This accordingly was done, and so the plague was stayed; and, in consequence of such a simple application of science to the common purposes of life, large quantities of food were redeemed from destruction, and much human misery providentially averted.

One more illustration, and I have done. The lichens, or aerial algæ, never grow submerged; the fuci, or aquatic algæ, never grow emerged: the same may be said of other plants which are the living demarcations of land and sea; e. g. the samphire (Crithmum maritimum) never grows but on the sea-shore, and yet it never grows within reach of the waves; that is to say, it is never so near as to be covered by the water. It happened not long since that a knowledge of this fact was useful in a way and at a time when botanic knowledge might *a priori* have been expected to be of little practical importance. During a violent storm, in November 1821, a vessel, passing through the English Channel, was driven on shore near Beachey Head, and the whole crew being washed overboard, four escaped from the wreck, only to be delivered, as they thought, to a more lingering and fearful, from its being a more gradual and equally inevitable death; for having, in the darkness of the night, been cast upon the breakers, they found, when they had climbed up these low rocks, that the waves were rapidly encroaching, and they doubted not that, when the tide should be at its height, the whole range would be entirely submerged. The darkness of the night prevented any thing being seen beyond the spot upon which they stood, and which was continually decreasing by the successive encroachments of each successive wave. The violence of the storm left no hope that their feeble voices, even if raised to the uttermost, could be heard on shore; and they knew that, amidst the howling of the blast, they could reach no other ear than that of God. Man could afford them no

assistance in such a situation, even if their distress were known. The circle of their existence here seemed gradually lessening before their eyes, their little span of earth gradually contracting to their destruction; already they had receded to the highest points, and already the infuriated waters followed them, flinging over their devoted heads the foremost waves, as heralds of their speedily approaching dissolution. At this moment one of these wretched men,—while they were debating whether they should not in this extremity throw themselves upon the mercy of the waves, hoping to be cast upon some higher ground, as, even if they failed to reach it, a sudden would be better than a lingering death,—in this extremity, one of these despairing creatures, to hold himself more firmly to the rock, grasped a weed, which, even wet as it was, he well knew, as the lightning's sudden flash afforded a momentary glare, was not a fucus, but a root of samphire: samphire is a plant which never grows submerged. This then became more than an olive branch of peace, a messenger of mercy; they knew that He who alone can calm the raging of the seas, at whose voice alone the winds and the waves are still, had placed his landmark, had planted his standard here; and by this sign they were assured that He had said to the wild waste of waters, Hither shalt thou come, and no further. Trusting, then, to the promise of this child of earth, they remained stationary during a dreadful yet then comparatively happy night, and in the morning they were seen from the cliffs above, and conveyed in safety to the shore.

Zoological botany is that section of our science which treats of the reciprocal influence of animals and plants upon each other, more especially with reference to their mutual support, defence, migrations, &c. It is, therefore, an extensive topic, as it includes an account of the advantages these two organic reigns severally receive and confer, as well as of the injuries they inflict and sustain, by which the one becomes a natural check to the undue increase and preponderance of the other. This research then opens a very fertile field of philosophical inquiry, and one that I cannot but think has hitherto been much too generally neglected, and yet which, notwithstanding this neglect, is even now far from being barren of facts or devoid of practical interest.

Few persons are aware of the extraordinary influence which even the smaller animals have on plants, and of the important service afforded to the vegetable kingdom, in maintaining a due balance of the various species by the apparent desolation caused by animals; for here the most ex-

tensive havoc is often, like the fire of London, a most extensive blessing.

Of these services, insects perhaps afford the most numerous and remarkable illustrations: hence, from the entomological section we shall draw our chief examples.

There is scarcely a plant that is not the peculiar habitat of one or more distinct species, and often the same plant is the domicile of many. The oak is frequented by a variety of other insects besides the numerous species of Cynips already noticed; nor is this a solitary example: other plants are equally infested. Furthermore, the insects themselves, or the diseases they produce, frequently become very important articles of food, medicine, and commerce: for example, the Kermesinus and Coccus, the Lac and Cantharides, the gall-apples of the Salvia pomifera, and the nut-galls of the Levant.

Ample as is the field, few and short are the examples which time will suffer us now to give; and it is to the less pleasing and apparently less profitable, although, on the whole, not less important duties of insects that I wish, in the first place, to direct your attention: for there is truly something quite wonderful in the contemplation of the devastating power of agents that seem so insignificant; something which is, perhaps, more impressive and appalling than when the causes are apparently more equal to the effects.

When pestilence depopulates a land,—when barbarian hordes lay waste the fertile plains of civilised communities,—when savage beasts devour and destroy flocks, herds, and harvests,—when floods, earthquakes, and volcanoes submerge, ingulf, or bury towns, men, and plains,—awful as are the results, still there is something less bewildering, less astounding in the contemplation of such catastrophes, dreadful as they are, because there is a more apparent concordance between the deeds and the agents by which they have been done, than when we consider that creatures so small as locusts can strip, during one visitation, whole forests of their foliage, and destroy every trace of vegetation throughout an extent of several thousand square miles together; and, as was the case when the kingdom of Masanissa thus was scourged, cause upwards of 800,000 persons to die from famine. What are the ravages of beasts,—what the desolation even of earthquakes and volcanoes, when compared to such an unsparing annihilation of men, brutes, and plants by these princes of the powers of the air.

Neither is our astonishment lessened, although its course be turned when we compute their sums, when we find the

swarms of these insects to be so vast and dense as to overshadow large tracts of country, and even to intercept the light of day. One of these living clouds, which was three whole days and nights, without apparent intermission, passing over Smyrna, must have been, according to accurate observations made at the time, three hundred yards in depth, upwards of forty miles in width, and nearly five hundred miles in length. Captain Basil Hall calculates "that the lowest number of locusts in this enormous swarm must have exceeded 168,608,563,200,000;" and, "in order to assist the imagination, Captain Beaufort determined that this cloud of locusts, which he saw drifting by when he lay at Smyrna, if formed into a heap, would have exceeded in magnitude more than a thousand and thirty times the largest pyramid of Egypt; or, if they had been placed on the ground close together, they would have encircled the globe with a band a mile and a furlong wide!" Indeed, history tells us that, when these conquering legions are subdued by tempests, their bodies occasionally overspread large tracts of country, even to four feet in depth, and, when driven into the sea, have formed a bank along the shore, three or four feet in height, and extending for fifty miles.

But we need not confine ourselves to foreign illustrations; for we do not lack examples nearer home of somewhat analogous, though far less fatal visitations, as the Aphides and Coccinellæ of our hop plantations, the flies of our turnip fields, and the timber grubs of this and other European countries will sufficiently declare. The Cossus ligniperda, or great goat moth, is a most powerful and destructive instrument in the hands of nature, and the rapidity with which this power is developed forms one of the not least interesting points of consideration. The larvæ of this insect have been proved by experiment to increase their weight 140 or 200 times in an hour, and, when full grown, to be 72,000 times heavier than when extruded from the egg. The willows near London, especially in the neighbourhood of Hackney, have suffered much lately from the depredations of this insect; but its ravages, and the rapidity of its increase, are nothing in comparison to those of the Termes bellicosus, which lays sixty eggs per minute, and will continue this operation for an almost incredible time, with scarcely any intermission, so that, at this rate, one female might lay 3,600 eggs per hour, or 86,400 in a day; and even a single female of the common flesh-fly, which is not the most prolific of its class, "will give birth to 20,000 young; so that, as my accomplished colleague, the Professor of

Geology, observes, there is some ground for the assertions of Linnæus and Wilcke, that three flies of Musca vomitoria could devour a dead horse as quickly as a lion; and that even the smallest insects can commit, when required, more ravages than an elephant, or any of our largest beasts. The importance of these scavengers of nature in removing suddenly effete and useless matter, will be acknowledged on every hand; but although they are employed with much advantage in alternating crops of trees and herbs in forest, grass, and other lands, yet, when they encroach on cultivated grounds, the injury which they commit is lamentable in the extreme.

Several instances immediately in point have been recorded by Mr. Brayley, in his Essay on the Utility of a Knowledge of Nature: he says, "The pine forests of Germany have at various times sustained enormous injury from the attacks of a small beetle, called Bostrichus typographus, 80,000 larvæ having been found in one tree; and, as they feed on the soft inner bark, and multiply thus abundantly, whole forests fall a sacrifice to their voracity, so that, in the Hartz alone, the trees destroyed were calculated at a million and a half; and the inhabitants of this extensive range of country were threatened with a want of fuel to continue their metallurgic operations, and consequently with ruin, entirely dependent as they were upon those branches of the useful arts." Subsequently these Bostrichi, when arrived at their perfect state, in the form of winged beetles, migrated in swarms into Suabia and Franconia, there to commit similar ravages. At length, after repeated injuries, the powers of nature interfered to mitigate the evil, which want of scientific knowledge, as we shall presently shew, had allowed to gain so alarming a head. Between 1784 and 1789, in consequence of a succession of cold and moist seasons; the numbers of this scourge were sensibly diminished: it appeared again, however, in 1790; and, so late as 1796, there was great reason to fear for the few fir trees that were left.

About twelve years ago, the elm trees in St. James's and Hyde parks suffered much from a similar attack, and whole rows were rapidly being thinned and disappearing, both in the Mall and the Birdcage walk. "As the persons who had the charge of the plantations were entirely ignorant of the true cause of the mischief, and as it was clear that the trees died in consequence of being completely stripped of their bark, rewards were at first offered for the discovery of the delinquents who so mischievously barked them; but these were offered in vain. It was observed, however, (and the obser-

vation claims some credit for its ingenuity,) that no more of any tree was barked from the ground than what was easily within the reach of a soldier's bayonet; and this was sufficient to throw suspicion on some unfortunate recruits, of whom more than one was arrested, without producing any diminution of the evil. In vain, too, were persons employed to sit up during whole nights, watching for the enemy; the bark continued to be found every morning at the roots of the trees, and the park-keepers, after all their trouble, could only conclude "that the bark fell off in consequence of something being placed on the trunks in the daytime." About the same time, the elms in the grove at Camberwell, near London, were observed to be undergoing a similar process of destruction; and the proprietors, being equally ignorant of its cause as in the instances just mentioned, the injury was ascribed to the effects of gas escaped from the pipes for lighting the road, which had just been laid down, and legal proceedings were actually commenced for the removal of the nuisance against the gas company which had undertaken the supply." Entomologists, it is true, were aware that the operations of insects were the cause of all this mischief, but unfortunately they were not believed until the disease had reached that pitch which threatened to make remedy hopeless. But at last a naturalist was consulted, and he at once discovered that an insect, called the Hylesinus destructor, had located itself in the parks, and legions of these little fellows were quietly and constantly at work, secretly proceeding in their labours of destruction, in spite and in defiance of Lord Sydney's denunciations. But not only did Mac Leay discover the cause of this evil: he, in the true spirit of philosophy, likewise directed a remedy to be applied, and these subtle miners became at once obedient to the voice of science, although they had defied the ranger's threats to prosecute them with the utmost severity of the law.

But insects not only do their bidding of destruction; they often defend plants from the aggressions of each other, and frequently protect the weak from the encroachments of the strong. Priority of possession gives many advantages to perennial and hardy over annual and more tender plants; and hence, were it not for the destruction of those by insects, or other animals, they would entirely overrun the land, and stifle the development of these. Hence, when left without interference, as in unreclaimed countries, do we find vast tracts known as the regions of forests, the regions of thistles, and the regions of grass; all of which are more or less intolerant of each other, and maintain for ages their lines of demar-

cation with the strictest and most arbitrary power: for, notwithstanding the thistle down, as General MILLER states in his Travels through Patagonia, is blown over the bowling-green-like pampas in such abundance that large balls are formed by its association, still few, very few of the seeds germinate, except in their own peculiar regions. Now, to modify such circumstances, and to restrain the monopolising tendency which all plants exhibit, various animals, and especially insects, are commissioned to curb their tyranny, by means the most simple, and yet the most effectual that can be possibly conceived. Thus, animals prefer for pasture those situations where their appropriate food is most abundant; and hence they quit those places where little is found, or when they have diminished its abundance. Insects, in like manner, colonise those spots alone, or chiefly, where the fit plants to feed their larvæ grow most freely; and hence it is that the preponderance is restrained; for the destruction or diminution of any over-bearing species will, of course, favor the growth and increase of many that are weaker; and when their mission is performed, that is, when the preponderance is reduced, then the messengers depart, for, as their food is lessened, their numbers are necessarily reduced: and it is one remarkable feature in this extraordinary system of checks and counterchecks, that, unlike man, few of the lower animals are omnivorous: each has its appropriate food, and what will starve or poison some will afford healthy and sufficient sustenance to others. Thus, horses will not touch cruciferous plants, but they will feed on the reed grasses, amidst abundance of which goats have been known to starve; and these latter, again, will eat and grow fat on the water hemlock, which is a rank poison to other cattle; in the like manner, pigs will feed on henbane, while they are destroyed by common pepper; and the horse, which avoids the bland turnip, will grow fat on rhubarb, and take a drachm of arsenic daily with advantage. In the general economy of nature, these idiosyncracies are of extreme importance; for thus each species, even when unsubdued by man, has a natural and wholesome curb placed upon its undue luxuriance, which prevents its increasing to the absolute exclusion of its fellows, and without which the balance could not be sustained. When, for dietetic or other purposes, it is wished that certain plants should occupy exclusively certain extensive tracts, art must then exert her modifying influence, and withhold the hand of nature with unwearied vigilance; for when, as occasionally happens, the artificial bonds are loosen-

ed, then do these natural agents demonstrate their power, as, notwithstanding the utmost care, continually is seen.

On the other hand, it not unfrequently happens that animals are of much service in aiding the increase and development of plants, not only by disseminating species, and by many seeds, as the olive and the hawthorn, &c., vegetating more freely after they have passed through their digestive organs; but also by insects aiding in the fertilization of flowers, conveying the pollen of those which are diœcious from the barren to the fruit-bearing organs, and thus becoming the intermediate means of impregnation.

Again, to vary the illustrations, we may note that a small grub, (the larva of the Musca pumilionis,) which its parent deposits in the acrospire of growing corn, does much towards increasing the produce of the plants, which it might have been supposed, from its devouring the plumule, it would irreparably injure. On the contrary, however, the tillering of wheat is much favored by such an attack on the germinating grain, and the number of culms considerably increased. Here it needs not to be told that the abundance of the harvest will greatly depend on the number of culms each grain produces, and these may be, and have been, multiplied to an almost incredible extent. A single grain of barley is recorded to have formed a tuft whence sprang 249 separate stalks, bearing as one season's produce above 18,000 grains; and a single seed of red wheat, which was experimented with by Mr. C. Miller, of Cambridge, son of the celebrated horticulturist, tillered so freely that it allowed of subdivision into five hundred separate vigorous offsets, which bare 21,109 ears, some of which contained between sixty and seventy grains; and "the wheat, when separated from the straw, weighed forty-seven pounds and seven ounces, and measured three pecks and three quarters, the estimated number of grains being 576,848!" *(Veg. Substan. L.E.K.)*

Of Geological and Mineralogical Botany, I must speak in common; for, although they diverge into different researches, time will not permit me to afford them separate illustrations. The latter is chiefly interesting from the indications it affords of the nature of soils, as by the Patellaria rufa never being known to grow any where excepting on sandstone of different degrees of hardness; the Lichen calcareum on limestone, and so forth; but not only do plants thus indicate the nature of the soils in which they grow, but also, at least as some persons say, (although, as far as I have examined the evidence, I do not think it is sufficient as yet to establish the

conclusion:)—some persons (I repeat it) think that not only the nature of the soil, but that of the subsoil also, and even the characters of the subjacent rocks, may be ascertained by a critical examination of the plants growing on the surface, as if nature had written the titles of her works on the outsides of her various volumes. But on this I had rather not at present dwell, as I am far from being satisfied with the instances as yet adduced, curious as confessedly they are; and we have quite enough of wonders that are indubitable to keep us from coveting any that are liable to doubt.

I prefer the term Geological to the older word Fossil Botany, because the former is more comprehensive and includes the latter, which name indeed very imperfectly expresses the extent of this department of our science; which investigates not only the characters of fossil plants, and their distribution in various strata, but also refers to their effects on climate, (for Meteorological Botany is not as yet sufficiently advanced, nor of sufficient extent, to constitute a separate section,) and notes the changes which vegetation is now producing upon the surface of the globe.

The geologist, or natural historian of the earth, must, to do his subject justice, call many collateral sciences to aid him in his researches, and not one of the least important amongst these is botany. To confirm the truth of my assertion, I think that I may appeal with safety to the learned professor of geology in this College; for in his very interesting work he has woven much botanical philosophy; and that part of our united studies which he blends with his, I likewise, although for a somewhat different purpose, include in my researches, and hence we shall be able mutually to assist each other. Thus, the geologist finds in various strata, and in different formations, the fossil remains of numerous plants, and the botanist is indebted to him for the discovery; but the former would reap little comparative advantage from his labour, did not the latter determine whether they are or are not identical with plants now growing on the surface of our globe, and decide the affinity of the extinct remains with the genera and species now existing, and distinguish ever-changing varieties from species, and prove the permanence of specific characters in plants. Often very sorry fragments are all that can be gained of fossil vegetables, and sometimes the impressions of the plants long since decayed are the only memorials which descend to us; and yet these are generally sufficient to shew whether they were similar or dissimilar to such as now are known, and whether the antediluvian flora had plants identical with or equivalent to our own. From

relics such as these before us, the vegetable physiologist can often tell what must have been the probable temperature and other physical conditions of the countries where such fossil witnesses are found, in eras so remote that, to the ignorant and the unlearned, they seem impossible to be submitted to the cognizance of existing man. Thus, when plants which we recognise as arboreous ferns and palms, and gigantic reeds, are found in various northern regions,—when plants similar to those which now are known to require intertropical heat are discovered in the temperate and towards the frigid zones, such discoveries attest to us not only the great climatorial changes which the earth has suffered, but they discover also those vast mutations which the apparently everlasting hills have undergone: and thus they register the mutability of what seems most immutable to man. Yes; these dumb mouths indeed do tell a tale of wonder, and in terms that cannot be gainsaid: they tell us that the heights of many of our mountain ranges were once beneath the sea; that the soil of our most fertile and most extensive plains is composed of the fragments of things which, like us and our modern animals and plants, once lived and moved, and had their transitory being upon this earth, although long since they have returned to it again; that the exuviæ of myriads, that the forests of ages, must have been concerned in the production of our bogs and peats, and especially in our coal formations; and furthermore they hint to us that, as they did not, neither do we, live wholly for ourselves, but that, as they conduce greatly to our comfort, so that, after we have lived our little here, our bodies, and those of our contemporaneous plants, like theirs, may be destined to subserve similar important services to generations which shall yet be born, in countless ages yet to come.

Oh, gentlemen, believe me, the feelings with which a botanical philosopher contemplates the various productions of the vegetable world are very different from those with which they are viewed by one unblessed by the light of science! How different is the barren knowledge of the existence of all these things around us, which every one knows to be, from a knowledge of the laws by which they are regulated and sustained. Never, indeed, to my mind, does true wisdom more fully vindicate her majesty and power, than when, as in this case, she thus unfolds a leaf turned down by nature, and reveals to us a record of those changes which long since have been forgotten, (if, indeed, to man they were ever known,) than when she thus turns back the pages of past time, and reads in these majestic tablets of the Creator the history of

his wondrous works, as published in the volume of creation. The whole earth, like Ezekiel's scroll, is written over, both within and without: to the ignorant and the thoughtless it may, perhaps, appear to be inscribed with mourning, lamentation, and woe; but to the philosopher it tells a constant tale of miracle and mercy, as HUNTER has well observed on a somewhat similar occasion: "appearances of this sublime nature may be compared to the handwriting upon the wall, which, although seen by many, was understood by few: they seem to constitute a kind of harmonious intercourse between God and man; they are, indeed, the silent language of the Deity."

*SYSTEMATIC BOTANY, or Vegetable Diagnosis, the second grand section of our science, objectively considered, includes, when liberally viewed, 1, Phytography or Descriptive Botany; 2, Phytaxonomy, or the Laws of System, as affecting the arrangement of vegetables; and 3, Phytochronology, or the Annals of Botany, comprehending the history of plants both natural and traditional, with the general literature and all other records of the science.

To Phytography, or Descriptive Botany, belongs the study, both theoretical and practical, of the verbal, pictorial, and actual representations of plants, either separately or in union: i. e. it consists in a knowledge of the terms invented to denominate, the figures designed to pourtray, and the means employed to preserve the various individuals of the vegetable world, and their various parts, under all their varied modifications.

The first of these subdivisions has been termed *Glossology*, or the Language of Botany; the second might be named *Botanography*, or the scientific Delineation of Plants; and the third is but a part of the conservator's province, which he designates *Taxidermy*.

The language of botany, called by the older writers *Terminology*, or the doctrine of technical terms, and by DE CANDOLLE, who objects to this word, *Glossology*, is a very fundamental part of systematic botany; for, notwithstanding it has been asked, and in a tone that almost precludes reply, "What's in a name?" still we must contend that, in matters of science, nomenclature is a subject of no mean importance.

* This section, and two or three other paragraphs, were, on account of time, omitted in the delivery of the first, and introduced into the second lecture; but, to pr serve the connexion of the argument, it has been thought better to let them appear in print in the places they were originally designed to occupy.

Botanists have laboured more abundantly, and perhaps more successfully than most other naturalists, to define with precision the terms they use, and to reduce their language to an acknowledged scale. Hence botany has long been famed for its "copia verborum:" and hence arises the brevity and perspicuity of botanical definitions; hence also the succinctness and clearness with which plants may be described, and the few words in which details of the most complex structures may be couched. Instead, therefore, of any exceptions being on this point admissible, it is to be regretted that the glossology of the other natural sciences is less advanced and far less perfected than, with all its faults, and we confess them to be many, the language of botany indisputably is, and the only matter for sincere regret is that philosophers cannot universally agree as to the meanings they severally attach to certain terms, nor even as to the terms by which they denote the same or dissimilar ideas; for not only are different words frequently used to express the same meaning, but, what is of far more injurious tendency, to one word very often several different significations are attached. Such indeterminate phraseology is the bane of science, and it were almost to be wished that some philosophic autocrat could compel, by an imperial *ukasse*, the invariable usage of different words for the expression of different ideas, and of similar terms to represent the same.

To prevent the baleful effects of this laxity of language, whenever and wherever it prevails, forms the most anxious part of the professor's and the most irksome of the pupil's duties; for, while current terms are used in science only to express their legitimate ideas, still the collateral significations cannot, and in good truth should not, be entirely overlooked: if we wish to understand those works in which the same words are less properly applied, either through the haste and carelessness of unscholastic writing, or from the errors which an imperfect acquaintance with vegetable physiology has introduced; and which, as our knowledge is day by day increasing, so it is daily rendering the views under which many names were given obsolete, and the dogmas they inculcate incorrect. This last is a difficulty inseparable from a progressive, a rapidly improving state of science; and it is a difficulty we need never wish to be removed. It is one that richly rewards us for any trouble it occasions, and its difficulties are readily overcome by all who are willing to learn *facts* as they exist in nature, without any exclusive deference to *words;* for, when things themselves are understood, the language in which they are clothed, although

important, is of secondary importance, and though different in different ages, and differently used by different persons, can scarcely obscure the subject greatly.

I always have been, and still purpose to continue, very jealous of the introduction of new names, well knowing that a workman may become burdened, and his labour hindered, by the multiplicity and complexity of his instruments and apparatus: yet I do not mean by this to avow any slavish adhesion to terms which are manifestly incorrect, or any fear of introducing a new word when a new idea requires representation, or an old one is either to be viewed in a new light, or can by a new term be more decidedly expressed; and hence I shall occasionally lie under the necessity of employing some technicalities that you will not meet with elsewhere; but these will never be introduced without a full explanation of their meanings, and in doing this I shall follow the example of the older botanists, and employ words as far as possible significant of the ideas intended to be conveyed, and with the same significations, whenever it can be done, in which they are ordinarily used.

One common word, however hypercritical the change may sound, I will confess that I do wish to see a little altered; and as it is one of the first we shall be compelled to use, and one that, of all, will be the most frequently employed, perhaps it will be as well at once to state it, and thus early to anticipate any objection that may not impossibly be raised to the substitution of the word *vegetal* for vegetable, in the drafts and diagrams which have been drawn out to assist in the explication of these lectures. This has been done designedly, and not by chance; for, as I have elsewhere observed, "How such an irregular and inharmonious word as veget*able* became established in our tongue, to the prejudice of the legitimate and more elegant (although now regarded as dis-*able*-d) vegetal, can scarcely be conjectured. This latter word, long all but obsolete, still has good authority to boast: Butler writes, "as from a seed, all sorts of *vegetals* proceed;" Burton also prefers this form; he says, "The earth yields nourishment to *vegetals*, sensible creatures feed on *vegetals*," &c. &c. Both *végétal* and *végétable* are current words among the French, and, as the latter can scarcely be exploded now, it is to be hoped that both will soon become equally familiar terms with us. My acute and learned friend, Mr. George Field, in his "Analogy of the Physical Sciences," has also well observed, "It is to be desired that custom should authorize the substitution of *vegetal* for vegetable, whether used as a substantive or adjective; for if

the terms animal and mineral be more proper than anim*able* and miner*able*, then, by correct analogy, *vegetal* is more proper than veget*able*." If custom, however, refuse to admit the euphonious vegetal as copartner with animal and mineral, at least let consistency pervade the whole, for *animable* and *minerable* are alone fit compeers for the cacophonious *vegetable*. Look on this column, and on that.

ANIMAL	}	{ ANIMABLE
VEGETAL	}	{ VEGETABLE
MINERAL	}	{ MINERABLE.

"Utrum horum mavis accipe."

Notwithstanding the acknowledged advantages thence derived, the language of botany has often been regarded with fear, and we still find it to be that part of the study most commonly objected to. This is not the only case, however, in which the facilities afforded by science have been ignorantly mistaken for difficulties inseparable therefrom: other instances could be given in which what we might perhaps be allowed to call the almost too exclusive privileges of botany, have been described as its peculiar disadvantages by those who little understood their import, and consequently were led to underrate and misrepresent their value. To these I shall not further now allude, but confine my present animadversions to this outcry against *hard words*, as the technicalities of science have foolishly been called; whereas, it should be remembered, as JOHNSON says, that "words are only hard to those who do not understand them," and, so far from our terms being really hard, the language of botany is more easy and intelligible, because it is more copious and precise, than that of the other natural sciences. To take an illustration: an exclaimer against hard words would, perhaps, when describing the figure of this ball, be content to say that it is round; another would declare this ring to be also round; and a third would as confidently assert both a cylinder and a coin to be round likewise; yet how various are these figures, and how greatly do they differ in their rotundity. Such wavering and inconstant language may suffice to express the ordinary ideas of ordinary minds, and nothing more; it is fit for such persons and purposes, and for such alone; and botanists may be therefore well content to bear the reproach even of pedantry for devoting distinct words to the representation of such distinct and varied figures, and for always, as in this case, preferring philosophic perspicuity to popular prejudice, and for insisting upon the use of different words for the expression of different ideas. Botanists

are not of that sect which declares that "language was given to man to conceal his thoughts:" we rather side with those who teach that the true purpose of language, and the great art of speaking, is so to express your ideas that they not only may, but must be understood, so to speak that your hearers not only may understand, but so that they shall not be able, by any possibility, to misunderstand your meaning, and the nearer any language approaches to this state, the nearer it approaches to perfection. Hence, although such persons as confine their researches to the books of men, without reference to the book of nature, who study names, not things, may bewilder themselves amidst the mazes of unintelligible technicalities which then, indeed, become uncouth and barbarous terms, which, in the hands of the skilful, are instruments of power: still, when botany is made, as it ought to be, a study of things, not a study of names, I will venture to affirm that there is nothing in its language that need excite our fear; for there is no science more easy in the acquirement, none which so soon rewards the pupil for a small, a very small outlay of study and attention.

I would, therefore, recommend all persons to indulge themselves in the delights of botany; for they will find it a relaxation rather than a toil, an amusement rather than a labour; a profitable pastime in youth, an agreeable occupation in manhood, and a gratifying research in honourable old age; when having, as we hope all who are educated here will do, passed through this world useful to their generation, and not useless to themselves; when having acquired, by meritorious exertion, a competency of wealth and a sufficiency of fame, they may retire, like Cincinnatus, from the senate to the field, and in a garden—(what pleasure is there not associated with the very name of a garden, it bespeaks at once serenity and ease,)—in a garden forget awhile this world, its turmoils and its cares, before they are summoned to quit it for a better.

Taxonomy, or Phy-taxonomy, the science of the laws of order or arrangement, as affecting plants, comprehends more than is generally supposed; for not only the principles of the natural and artificial schemes should in this section be considered, and the practical utility of both explained, but much physiological research will be requisite, and should be here employed in the selection of the organs from which, by their comparative immutability and relative importance in various tribes of plants, the characters of classes, orders, types, genera, and species, can most satisfactorily be drawn, and on which the distinctions of these several groups can be most securely founded.

The association of varieties, the determination of species, and the demarcation of genera, which should be neither too loosely comprehensive nor too fastidiously confined, will likewise demand no less acuteness to discover their true extent, and ability to define them, than energy to resist all useless subdivisions and puerile innovations; for excessive analysis should be as sedulously shunned as excessive synthesis: both are inimical to the progress of philosophy. Furthermore, the imposition of new names, the retention or rejection of old ones, which have often been carelessly and most waywardly imposed, as well as the collation of synonymes, (a most useful but very thankless task,) will require much unobtrusive botanical and historical research. But of this enough: whatever further observations there may be to offer on the formation and revision of genera and species, on generic and specific names, their construction and correction, the study of synonymes, and so forth, I shall reserve for a future lecture.

One hundred thousand may be esteemed a very moderate computation of the existing number of vegetable species: were registered varieties and fossil plants to be enumerated, the amount would probably be much more than doubled. Now that branch of our science which teaches to distinguish with facility all these multitudinous particulars, which, without being reduced to lucid order, would seem almost infinite, and gives to its possessor the privilege of calling them each by their names, can require little to be said in commendation of its utility, or to recommend it to the favor of the natural philosopher; but time, the enemy of all our deeds, and yet by whose means we do all that is ever done, forbids me on this occasion to do more than offer the most cursory illustrations of its several departments: if, however, a proof should be required, that which we anticipated in the first section of this lecture, viz. the errors that had occurred, and the injuries that had been sustained, from not discriminating the different species of our native oaks, may be confidently referred to; and as a second illustration, should another be demanded, or one more strictly professional be preferred, we need only advert, and that only for a moment, to the uncertain state of physic before *herbcraft* (as it once was fitly called,) had assumed the nature of a science: for, of all the plants used by the ancients as medicines, and many of them would, from the accounts transmitted to our times, appear to have been possessed of important powers, how few are there of which we have positive knowledge, or to which we can now refer with any thing like tolerable certainty? In fact, of the vegetable materia medica of the ancients, we know absolutely next to

nothing. Nor can this be wondered at, when we take into consideration their methods of describing plants, (if methods they can indeed be called.) Thus on reference, for example, to the works of DIOSCORIDES, who wrote especially on herbs as medicines, we shall find that in his descriptions, when any are found, (for often there is no attempt at diagnosis,) that he compares them to each other, either totally or in their several parts; i. e. when treating of any given plant, he compares it to another; and if the type be examined, that will be found to be compared to another, and that again to a third, which he presumes to be better known and more familiar, and so on through a lengthening chain of types, ectypes, antitypes, and prototypes, until the inquirer is bewildered amidst such a variety of guides. Thus Calamintha, Acinos, Ocimastrum or Ocimoides, Erinus, Solanum, Mercurialis, and Heliotropium, are all compared to Ocimum *vulgo cognitum;* while it must be confessed that the Ocimum of Dioscorides, however familiar then to him, is now utterly unknown to us. Indeed, it would be difficult to say what vegetable it could be to which so many very dissimilar plants could be compared, or what plants they possibly could be which might be compared to it; certainly not those which now possess the names which he makes use of: for how could our Calamint, Nightshade, and Heliotrope be likened to each other or compared with the same type, our Ocymum; i. e. flowers with distinct and syngenious anthers, with regular and irregular corollæ, to a didynamious labiate Basil? Again, Dioscorides compares Centaurium minus, Tragoriganum, Serpyllum, Marum, Polycnemon, Symphytum petræum, Ageratum, and Papaver erraticum, to Origanum; then Origanum, the type of all these plants, is compared to Hyssopus, which thus is made the clue to Origanum and all the rest; and Hyssopus is described as being "*known to all;*" but it so happens that the hyssop of Dioscorides is now not at all known, instead of being, as he says, "known to all." These examples have been selected by GRAY for the purpose of shewing, and none could shew more forcibly than these, the importance of systematic arrangement, and the necessity of establishing accurate botanical diagnostic signs, by which one plant may be distinguished from another, not only when seen by the teacher or when shewn personally to the student, but by which we may be enabled to communicate our knowledge to distant lands, and record our discoveries for the advantage of distant times. Science should be not only progressive but cumulative, and it is by system alone that we can thus, as it were, annihilate for knowledge both time and space.

The third sub-section of this branch of botany relates to the records of what was known and discovered, or misunderstood by the ancients and our later predecessors: and we include all dissertations and fragments relating to such and collateral subjects under the general terms of Botanology or Phytochronology; that is, the history or chronicles of the science.

This mnemonic section will afford much curiously interesting matter for archæological research, as the illustration just taken from Dioscorides may serve to shew; and let it alone suffice as proof; for the length to which even our short notices of the previous departments have already reached will prevent the introduction now of any more particular examples; and therefore those which I had selected from profane and sacred sources must be postponed to a future opportunity. Here, however, I would advertise my classes, that I do not purpose entering deeply into biblical criticism on the identity or names of plants, as more than any modern pen could hope to write has been already written by Scheuchzer, Celsius, Prosper Alpinus, Forskal, and others, and, moreover, I think the subject, as it admits not of demonstration, the legitimate purpose of public lectures, can be more advantageously pursued in the closet than in the theatre; and hence I shall only conduct them to the threshold of this department, and leave them to pursue such researches in the library, where alone the fit means for their successful prosecution can be found.

We now approach the last grand section of our science, viz. Economic Botany, which includes a knowledge of the purposes to which plants either have been, are, or might be applied as food, as medicines, or in the arts.

This knowledge is in part empirical, in part philosophic, and the more we can redeem it from empiricism the more shall we lessen the labour and privations, the more shall we increase the comforts and the conveniences of man. Agriculture has truly, though figuratively, been called one of the breasts of the state; and, indeed, when we consider that half an acre of arable land affords as much human food as eight hundred acres of hunting ground, the praise will not sound extreme. The application of botanical philosophy to georgical pursuits has already had a most beneficial effect; for we learn, on good authority, that since the theory of assolements, or the mutation of crops, which in this country is called the turnip husbandry, because that vegetable, by us, is the most frequently alternated with corn, has been understood and partially introduced, although prejudices prevent its entire adoption, (for there is still in this land much of the fearful

inertia of ignorance to overcome,) that notwithstanding the extent of arable land has decreased, the crops produced from the lessened area have been increased, not merely in a relative but in a positive degree; i. e. an absolutely larger supply of food has been produced, although a considerably less extent of land has been tilled. And if he deserved a civic crown who caused two blades of grass to grow where only one had grown before, should that science be neglected which not only teaches this, but more; which not only increases, but, as it were, creates our food, especially by those who dread a surplus population? Science has already more than doubled, probably it will triple and quadruple our supplies of food; for the resources of philosophy are not yet exhausted.

This increase, however, is, as I have said, far from being all that we have here to notice; for scarcely is there a plant we eat that has not been in a manner *made* (at least as an article of food) by man. The means of sustenance have been provided, but those means must be improved: plants have naturally an appetency for amelioration, otherwise they could never thus be changed; and when they are again neglected, they return to their former state, and their degeneration equally proclaims and punishes man's want of care: so sure has been the word, so strict the fulfilment of the denunciation, that, if he will not work, he shall not eat.

Wheat, the illustration first alluded to, is of this an excellent example; for so changed has it been by culture, that its native stock can nowhere now be traced, it can be recognized nowhere wild; or if, as some suppose, it has been found in Thibet, the offspring is so much altered that many doubt the legitimacy of the descent.

Horticulture is but an offset of agriculture, and its operations are many of them copies of its original on a smaller scale; and yet, from its devotion to tender and exotic plants, it has practically become a separate pursuit; and the changes which have been wrought by art on the subjects of the gardener's care are so strange, that, even when the evidence amounts to demonstration, we can scarcely esteem them true; e. g. the cauliflower, weighing several pounds, and the cabbage, which often reaches half a hundredweight, are both produced from a wildplant, the leaves of which do not amount to perhaps more than half an ounce, and the peduncles of which probably not to more than half a drachm. The delicious celery, also, is formed from the acrid and poisonous smallage; the asparagus and sea-kale, so bland and mild, uncultured are austere and nauseous; wild carrots and parsnips

are like sticks; and potatoes are bitter, small, and often deleterious. The changes, indeed, effected by culture in plants, are quite as great and as surprising as the changes wrought by education in mankind; nor is there a greater difference between the Briton and the Boshiesman, than between cultured and uncultured plants: for example, who would think our most luxuriant apples the offspring of the austere and verjuice crab? The cat's-head and some Normandy pippins will singly weigh from eight or ten ounces to a pound, which is often as much as the entire crop of the aneestral crab. Again, who in the wretched sloe would recognize the parent of our most luscious plums? or who, in the almond's rough and leathery coat, would discern the rudiments of the juicy peach? Yet such are the changes which culture has effected; for education, if we so may speak, is not less potent in softening constitutional austerities in plants than we know it to be in smoothing the natural asperities of men, so that to them we may apply what has so beautifully been said of us:

"Emollit mores nec sinit esse feras."

Dietetic, medical, and mercantile, are but artificial applications of this science to the purposes their names declare: of their importance, however, no proof is wanting; vegetables afford their chief food both to men and beasts, some nations wholly live on plants; and to almost all, vegetables afford their staple diet. As articles of commerce, I need only allude to one or two examples; take for instance opium and tea: the latter of which alone yields a yearly revenue of about £3,300,000; and the importations of opium amount in value to upwards of £3,000,000 per annum; tobacco likewise yields a yearly duty of £2,800,000 and the trade in opium between British India and China, although contraband, brings to the Indian government a revenue of £1,800,000 sterling. How different likewise, in a political point of view, would be the influence of this country, both in the east and in the west, if a tropical grass should no longer yield sugar; or did the Gossipium even for a year cease to clothe its seeds in cotton! it would be anything but a golden age if the poet's dream were realized, if all things could by every land be borne.

As most of the public professors of Botany have been medical men, and as it owes much of its advaneement to their exertions, it is no wonder that this sciene should often he considered more purely medical than it really is; for the medical section has long formed its most prominent, and with the worldly its only redeeming feature. Therefore, with regard to medicine, the importance of botany scarcely need be mentioned; for granting to the full the value of mineral remedies

(and no one is more willing to acknowledge their importance than myself,) still what drugs can compete with opium and cinchona? to say nothing of rhubarb, aloes, and colocynth, ipecacuan, colchicum, and camphor, senna, elaterium, and many, many others far too numerous now to catalogue; amongst which are several of our native plants, which are only left unused, unthought of, and almost unknown, because they are indigenous and common; and yet which, as I elsewhere have observed, I cannot but think have of late been too much neglected; for certain is that we compass half the globe to import a drug, the prototype of which not unfrequently solicits our hands at home. I, for one, can never think that all those plants are useless that we use not; that such countless myriads of beauteous herbs which spring profusely wild over all the deep green earth, spring oft in vain, because in vain they court man's notice and regard. I never can believe that Providence has armed the weeds of foreign lands with powers necessary for us, whilst ours are impotent to heal. I never can believe our herbs inert, whilst every plant in other climes may boast itself a physician's staff.

I have already advocated the advantages of labour, and we must all confess the peculiar advantages those men enjoy who by their station are compelled to work: we know that it is by a merciful dispensation that man has been condemned in the sweat of his brow to eat his bread; for we see that, where necessity compels not to exertions, indolence debases man almost to the level of a brute; and hence we are convinced that where most is required for the body, there most fully are developed the energies of the mind: still we cannot but perceive that many of our native plants want but to grow upon the Andes or the Alps to be sought with avidity and treated with respect. It is therefore a matter of no mean importance to which, by a resolution of the council of the Medico-Botanical Society, the attention of the scientific world has been directed, by their determination to award an honorary silver medal to the author of the best essay on the nature and properties of any indigenous plants, the medicinal powers of which have been hitherto unknown or only imperfectly recorded. Already this has produced a valuable dissertation on the medicinal properties of the holly, the powdered leaves and extract and bark of which, with probably a peculiar proximate principle called ilicine, and which by their favor I now have an opportunity of exhibiting, is shewn to be a powerful febrifuge, and said to be a worthy substitute for cinchona. A communication has likewise been made respecting the medicinal properties of the common yew (Taxus baccata), which is

said to possess a power equivalent to that of digitalis over the circulating system; with this advantage, that it may be exhibited without disturbing the brain and without any fear of producing the fatal results which occasionally follow the administration of foxglove. To me, then, it appears that this will be sinking a shaft in a very rich mine of scientific discovery, of truly philosophical investigation; and I doubt not that we shall find many of the remedies now sought from the tropics and the poles growing at our doors, and soliciting to be allowed to relieve our ills. It is an amiable idea, and one that experience goes far to verify, that wherever natural circumstances favor the production of disease, nature, (i. e. nature's God,) hath beneficently conjoined the means of cure. May not the late experiments on the holly and the willow be given here as illustrations; for, although we have so long been ploughing the Atlantic, and burdening the bosom of the deep to bring home our harvests of Peruvian ague-cure, the ever-valuable cinchona, ilicine extracted from our hollies, and salicine from our willows, as far as experiments as yet have gone, prove equally effectual in the cure of intermittent fevers with the quinine of Peruvian bark. And where do agues most commonly prevail? where do we find remittent and intermittent fevers in the greatest frequency, and of the most fatal severity? where? but in wet low lands, in marshy and fenny districts; and where do willows love to dwell? where? but in those very fens and marshes? as if planted by the hand of Providence to relieve the diseases inseparable therefrom: and hence I cannot but regard them as the living elaboratories of nature to provide medicines for the benefit of man. (*Dissert. inaug. Med. Bot.*)

Such, Gentleman, are plants, and such their attributes: the former I illustrated in the introductory lecture of the prior section; the latter, as giving rise to the three great branches of vegetable physics, organic and systematic botany, I have endeavoured, though faintly, to delineate in this. No one is more sensible than myself how faint the outline is, how imperfect the details: no one feels more fully how weak the isolated illustrations must appear, severed as they necessarily have been from contingent truths, the strength of which is common and consists chiefly in their union. To me they seem like certain buds violently plucked from this branch of the tree of knowledge, and opened perforce by art. Like such buds or bulbs, which thus discover the rudiments alone of what the seasons would develop; and like such premature examinations, which can give very insufficient ideas of the beauty and the worth of the curious gems the rude hyberna-

cle encloses; so it seems to me, in truth, that I have done little more than present you with a branch in its wintry state, devoid of leaves, and flowers, and fruit, which are to become its ornaments and chief recommendation; have rudely opened some few of those little buds with which it is so richly studded; have presented you with nothing further than a bare and naked trunk; but which, having within it the vigour and vitality of truth, will, I trust, blossom and bear fruit some thirty, some sixty, and some a hundred fold, now that it is planted in the fertile soil of your own inquiring bosoms.

Gentlemen: before bidding you this day farewell, it may be possibly expected that I should state the reasons which have induced me to commence this season two contemporaneous courses of such very different extent; because it may perhaps be thought by some that if the most extended be not too long to teach the science, the shorter must be insufficient for that purpose. Even when I offer, in apology, my intent to discuss in one the general only, and in the other both the general and the particular details of botany, I know that some will immediately retort, (for the objection has been already raised,) that general knowledge is only another name for general ignorance. To this, however, I cannot assent; such an objection seems to me more terse than true, more sonorous than sound; for general knowledge, in the sense that I understand the term, in the sense in which I use it, means a knowledge of those laws or truths which are common or general to many individuals, or groups; and especial or particular knowledge, in like manner, means a knowledge of the truths appertaining to each individual, and which are special or particular to it or them alone. Knowledge is not the less knowledge because it is but a little knowledge, or goes but a little way; much less can that be ignorance which, if little now, is only now what most great things must once have been. Thus, for example, we all have a general knowledge of many persons and of many things with whom and with which we are not particularly acquainted, just as a general has a general knowledge of the army under his command: he knows the number and the available strength of the various regiments; he knows the proportion of horse and foot, the locality of the corps, and so forth, although he may not be particularly acquainted with each individual soldier, or even with the subaltern officers, of every battalion. With one regiment, that of which he himself is colonel, he will be particularly acquainted; but of the others, it will be sufficient that he have a general knowledge, which will enable him at any time to descend to particular inquiries, that without it could not easily be done. Thus also my col-

leagues and myself may have a general knowledge of the mode in which all the lectures are given within these walls, the different theatres in which the courses are delivered, the extent and object of the several studies, the number of the students in each class, and so on; although we may not know the individual pupils by name, or even by sight, of any classes except our own; and yet, with such a general knowledge, how easy is it for us to arrive here in time to be present at any particular lecture, to meet any particular professor, and to become acquainted with any particular student, which, devoid of such general knowledge, or the ready means of obtaining it, could not be done without much useless fatigue and probably many disappointments.

From this it will be seen that I am far from disparaging, very far from despising, such general knowledge: to me it seems like guarding the outposts or garrisoning the frontier towns or fortresses, whence inroads may be made at pleasure, and with safety, into neighbouring provinces, which would be otherwise impenetrable; nor have I often found those that are possessed of the least general knowledge the most proficient in special studies: on the contrary, they who have received the most liberal education in the general sciences are frequently the most fitted to follow with advantage any particular pursuit.

"Non omnia possumus omnes," methinks the idle will immediately exclaim, and I will grant them the full force of their quotation: nay more, I will grant, without fear and without prejudice to the cause, the non-expectation as well as the non-ability: I will grant that no one is expected, as indeed no one man is able, to know all things; yet every one must know something. Universal ignorance and infinite knowledge are alike impossible to man; all are in some measure philosophers, yet, for a few who become really lovers of wisdom, how many remain for ever sophists. No person *can* entertain *too* liberal, many have too contracted views of science; few lay their foundations on too wide a scale, many build on too slight a basis. Hence arises the necessity, on all possible occasions, of inculcating a due regard for sound principles in every department of philosophy; for on first principles, as on first impressions, much subsequent importance will attach; and the mind which science does not cultivate and improve, ignorance will lay waste and over-run with errors.

Confined as we are to place and time, as it would be impossible for the natural eye to survey at once the whole of the terrestrial globe, so would it be impossible for a finite mind to behold at once the entire sphere of knowledge. The view

in both instances must be partial, but of greater or less extent, according as obstacles are raised or overcome, and as the means employed are more or less adapted to the purpose: yet by an horizon would the prospect be necessarily bounded in which objects might appear trifling from their distance or vast from their obscurity, from which unknown regions the slothful would retreat with terror, but towards which the active mind would be urged by its anxiety to explore.

Let me pursue the metaphor: there is a mental as well as a corporeal eye, an intellectual as well as a material view. In both cases by an horizon is the prospect bounded, in both cases may vision be extended or obscured. Placed by nature on the plain of animal existence, man may either descend the vales of ignorance or ascend the hills of science; he may either indulge his animal propensities or cultivate his intellectual powers; the lower he proceeds, the more contracted is the circle of his knowledge; the higher he mounts, the more clear and extended the horizon that bounds his view; for the obstacles which in the one case are increased and succumbed to, in the other are lessened and subdued. Still in all cases is the horizon of the intellectual and material eye obstructed by some obstacles it *cannot*, but more frequently by others that it *will not* endeavour to surmount: for in matter only is ignorance universal, and in mind alone is knowledge boundless and complete. Therefore, the lower we look in creation the less is the capacity, and the higher we look the less the incapacity; yet in the one instance such beings attain all they are capable of acquiring, and in the other, too often, that only which they are unable to avoid. Yes, man may so pervert his talents that he may be degraded to the lowest level of humanity and become little higher than the brutes; or he may so cultivate his reason, and elevate his soul, as to be but little lower than the angels, blessed with knowledge, and thence with power. Thus, although our most extended views are necessarily confined, still they may be much contracted or enlarged; and those methods well deserve the attention of man by which his prospects through this journey of life may the most be varied, and to the utmost be extended and improved: he need never fear they will become too general or complete: and as in the regions of science as in the regions of the earth, there are certain sublime and elevated spots whence may be obtained enlarged and liberal views of surrounding districts, to these should all repair and feast their eyes with repeated visions of the richness and majesty of nature, as seen through the telescope of knowledge; but to mortal eyes the glimpse must still be partial, for now we see

but as through a glass, darkly, and until we have "shuffled off this mortal coil," we never can even hope, how much soever we may often wish, to behold at once all the regions of science and the glory of them.

With regard to the subjects to be discussed in these two courses, they will be in both the same; in our daily prælections every topic will be fully treated; in the weekly summaries the various points demonstrated at length will be condensed into a more popular, and made to assume a less scholastic form. To those who attend one of the courses only, each will be in itself complete; to those who attend them both, the one will become a comment on the other: to both classes an opportunity of extra instruction will be afforded; from neither will there be anything abstracted: and therefore to the plan I do not anticipate objection. To those who entered to the autumnal lectures, I need not promise, neither from them need I ask, punctuality of attendance; but for the sake of such as may be fresh-men here, it will perhaps be right to say that they will always find me punctual to the hour, and that I shall hope to find them punctual in their attendance also. I do not, I repeat, address these observations to those who attended the previous course; for if the lectures were in any measure worthy their attention, (and from their very regular attendance I am encouraged to hope they were,) I will confess that much of whatever merit they possessed must be attributed to this regularity in their attendance; and I would entreat every one to remember that in this case more depends upon the pupil than upon the professor, and never to forget that, excepting to a good class, it is next to impossible to give a good lecture.

Gentlemen: having, as I trust, reconciled you to my plan, it only now remains for me to thank you for the kindness with which you have received, and the attention with which you have listened, to a long, and I fear in some respects a tedious lecture; to offer my grateful and sincere acknowledgments to those noblemen and gentlemen, and to those senior members of our profession, who delight to honour science by assembling within these walls; and to assure them that nothing will give us greater pleasure than to see them often here, as often as their numerous and important avocations will permit. To my junior auditors, and to those who purpose becoming industrious rather than amateur students, I have an additional word to say.

Gentlemen, I would beg you to consider yourselves as setting out upon a journey of some extent, through a country of which you are ignorant, or at least with which at present

you are imperfectly acquainted; and I would beseech you to look upon me as your guide, your friend; or rather as both guide and friend; a friend who, having often trod this path before, (he knows with much pleasure to himself, he hopes with some profit to his companions,) is now willing to recommence the journey, and, by his acquaintance with the road, to lessen the labour of his fellow-travellers, and to smooth their way whenever it becomes difficult or rugged; for the course of science is sometimes arduous as the mountain path, and yet like the mountain path, it is often most beautiful where steepest. Botany, like all other studies, requires for its successful pursuit some small share both of ardour and attention, but certainly much less than has been frequently supposed; not more, perhaps far less, than many collateral sciences would seem to demand. For we ask not that entire dedication of the mind which some abstract and speculative philosophers have claimed from those who offer to become their pupils; we only ask attention.

I think we hear too much by far of the rugged road to learning, too much of "the steep where fame's proud temple stands," as if to deter, even whilst inviting, the timid yet ingenuous aspirant: the road, believe me, has many beauties in its course; the steep has many steps to ease its weary height; and they who have trod the path well know that it is not very rugged; they who have scaled the steep well know that it is not very high; the one is rugged only to the slothful, the other steep to such alone as lie grovelling at the base. Let but the will be father to the deed, and then the deed is done. Tell me not of the student's midnight toil, I know it to be rather the midnight pleasure; for what time is ever so much enjoyed as that which, redeeming from perdition more truly than any other, we may call our own: what hours are ever so dear when present, so doubly dear to memory when past, as those in which we wake and work while others sleep.

Forgive me if I am wrong, perhaps I am too hasty in my conclusions, perhaps I generalize here on insufficient grounds, on too meagre an association of particulars. There may be, in studies foreign to my pursuits, difficulties that I know not of; it becomes me, therefore, not to speak decidedly of other sciences, but to restrain my positive asseverations to my own: and yet if others truly tell of the thorny paths which lead to their shrines of knowledge, why then it must be confessed that we botanists alone of all are privileged to strew our way with flowers.

I did intend, and would fain have given some cursory illustrations of each of the several chief departments of botany,

both of the general sciences of Fungology, Algalogy, Muscology, and so forth, as well as of the more special studies which, by some of our most able naturalists, have been so successfully pursued; but time forbids,—and even devoting, as I have done, this hour almost entirely to one view of the science, I have been reluctantly compelled, in my brief notices of vegetable physics, systematic and economic botany, almost entirely to omit some sections, and to pass over in others so much, so very much, most important and interesting matter, that I repent me of the boldness of my design, having fallen so grievously short in its execution. But, gentlemen, faint as the sketch has been, such are plants and such is botany; such the beings to be studied, such the schemes of study, such the subjects, such the objects of this science; a science as extensive and as important as any branch of natural knowledge; a science which, in beauty and in interest, yields to none: for although the tin box, the knife, and the glass, which are almost the whole apparatus that, as botanists, we require, look but meanly when compared with the costly machines of the mechanical philosopher, or the imposing paraphernalia of the chemist, although we cannot surprise you with the exhibition of human ingenuity or astonish the uninitiated with such brilliant experiments as the laboratory affords; although we cannot waken the heavy eye by shutting up the sun in a bottle, or rouse the dull ear of sleep by the syren tones of the girl they call invisible, still we have works of surpassing excellence to display, the handy work of one who never fails. We have experiments (i. e. observations) to make in a laboratory unequalled by human art; we have living alembics with which to work, and with us the processes of evaporation, precipitation, and distillation are carried on to an extent, and are performed with a certainty and an exactness utterly unapproachable by man. Yes, we also have a sun that illuminates our paths in search for truth; we also have the voice of one invisible to which we listen, a still small voice, which, although inaudible by outward ears, mentally is heard telling a tale of wonders. And thus, as I have endeavoured to convince you, we botanists are not without advantages and pleasures, some of which are peculiarly our own; and we think them not the less worthy of regard because they are enjoyments within the reach of all, or because they are privileges that can be so cheaply bought.

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